Ugolini, A., I. Carmignani and M. Vannini. 1986. Mother-young relationship in *Euscorpius*: Adaptive value of the larval permanence on the mother's back (Scorpiones, Chactidae). J. Arachnol., 14: 43-46.

MOTHER-YOUNG RELATIONSHIP IN *EUSCORPIUS:* ADAPTIVE VALUE OF THE LARVAL PERMANENCE ON THE MOTHER'S BACK (SCORPIONES, CHACTIDAE)

A. Ugolini, I. Carmignani and M. Vannini

Dipartimento di Biologia Animale e Genetica
Università di Firenze
v. Romana 17, 50125 Firenze, Italy

ABSTRACT

Mortality rates were measured in *Euscorpius flavicaudis* larvae which had been made to stay on their mother's back (as actually occurs in nature) or had been separated from their mother, under three different relative humidity levels. Mortality was greatest among larvae exposed to low RH levels and in any cases, among larvae separated from their mother. The mother-offspring relationship likely serves several functions: it is an obvious defense against predators and provides an optimum micro-habitat selection. These experiments suggest that the mother may also provide a greater resistance to dehydration, either by water-proofing the larvae or by refurnishing their water loss.

INTRODUCTION

The permanence of the larvae on the mother's back after birth is an universal feature among scorpions. In spite of investigations by Angermann (1957), Torres and Heatwole (1967), Le Pape (1974), Vannini et al. (1978), Vannini and Ugolini (1980) and Ugolini and Vannini (1983), evidence is still lacking as to the exact adaptive value of this behavior.

Defense against predators and maintenance of the larvae at more optimal microclimatic conditions seem plausible (Williams 1969, Maury 1969, Vannini et al. 1978, Vannini and Ugolini 1981) but some kind of trophic exchange has also been hypothesized (Alexander 1977).

The purpose of our work was to investigate whether larvae raised on their mother's back and larvae isolated from their mother exhibit the same survival rate under stressful environmental conditions of low relative humidity.

MATERIALS AND METHODS

Pregnant females *Euscorpius flavicaudis* (Geer) were captured near Florence (Italy) in August-September 1980-1982. In the laboratory the animals were reared individually in small containers under natural conditions of temperature, relative humidity and photoperiod. They were given *Tenebrio molitor* larvae and water once a week. No food or water was administered during experiments.

Within 24 hours of birth, each litter was divided into two or three groups: 1) larvae put back onto their mother (OM); 2) larvae separated from their mother

Table 1.—Mortality rates (total number of deaths/total number of larvae tested) with respect to relative humidity (RH) and treatment; OM, larvae on mother; WM, larvae without mother: n = number of broods.

	RH:	10%	60%	90%
treatments:	OM	47/132 (35.6%)	10/130 (7.7%)	5/112 (4.5%)
	WM	91/16 (71.2%)	32/139 (23.0%)	6/123 (4.9%)
	n=	9	13	11

but grouped together in a single container (WM); and, in certain cases, 3) larvae separated from their mother but also isolated one from another (IS). Each group was exposed to one of three levels of RH (10%, 60% and 90%), obtained by using $CaCl_2$, environmental RH and distilled water, respectively.

The larval mortality rate was then measured for each type of treatment and defined as the ratio between the nymphs still alive after the first moult and the initial members of each group.

RESULTS

The comparison of the experiments on larvae kept at 10%, 60%, and 90% RH, on the mother and without the mother (Table 1), shows that the larval surviving probability increases at higher RH levels, and, in general, in presence of the mother.

The effect of the presence/absence of the mother can be tested by applying the Wilcoxon matched-pairs test (Table 2). The absence of the mother is shown to increase the larval mortality rate at 10% and 60% RH but not at 90%.

It is possible then to compare the mortality rates at different RH levels by applying the Mann-Whitney test (Table 3). The differences between 10% vs 60% and 10% vs 90% RH are always significant, whereas the difference between 60% and 90% RH is only evident among the larvae separated from the mother.

The presence of the mother is therefore reducing the larval water loss. The larvae, when on their mother's back, are usually highly aggregated. The larvae without the mother are usually found aggregated at low RH, whereas they appear largely scattered at high RH levels. The presence of the mother could then reduce the larval water loss, independently from any substances exchange, by simply inducing their aggregation.

The effect of the aggregation on the surviving rate was then measured comparing (only at the lowest RH level) the behaviour of larvae with the mother, without the mother but free of aggregating and without the mother and isolated from each other (Table 4). The analysis of the results show the aggregation effect is anyway quite negligible.

Table 2.—Comparison between mortality rates on and without mother. T = statistics of Wilcoxon matched-pairs test (two-tailed); N = number of matched pairs whose difference is not zero; in brackets, total number of pairs.

RH	10%	60%	90%
N=	12 (13)	10 (13)	6 (11)
T=	4	0	7
P	<0.05	<0.01	n.s.

Table 3.—Comparison between mortality rates on the mother (OM) and without the mother (WM), at different RH levels. U= statistics of Mann-Whitney test (two-tailed).

	RH:	10% vs 60%	10% vs 90%	60% vs 90%
(OM)	U=	5.5	5.0	67.0
	P	<0.002	<0.002	n.s.
(WM)	U=	15.5	7.5	22.5
	P	<0.002	<0.002	<0.02

When is dehydration mostly affecting the larval survival rate? The 91.5% (279/305) of the dead larvae were dead the moulting day or the day before.

DISCUSSION AND CONCLUSIONS

Larval aggregations are a universal and necessary feature of scorpion life history. Such aggregation is accomplished both by larval behaviour (fallen larvae climb back onto their mother's back; Vannini et. al. 1978) and chemical cues favoring their permanence on the mother (Torres and Heatwole 1967, Vannini and Ugolini 1980, Ugolini and Vannini 1983).

It is possible that the mother provides protection for their young in a number of ways:

i) when the larvae are on their mother's back they are probably safe from a wide range of potential predators (other scorpions, spiders, ants, centipedes; Polis et. al., 1981) which are unlikely to harm larger scorpions;

ii) movement by the mother allows selection of more suitable microhabitats while larvae are quite limited in their movements.

Our investigations show two additional advantages:

iii) by aggregating together on the mothers there is a passive decrease because of boundary layer effects, of water loss and subsequent dehydration;

iv) the larvae on their mother's back are more likely to survive the moult without mishap.

Could advantage iv) result from trophic exchange between mother and young? The larvae never participate in their mother's meal, nor do they tend to take up a position near her mouth-parts; this excludes any oral exchange of food and water between the mother and her larvae. It is possible that the mother secretes wax or water through her cuticle and this in turn is absorbed by the larvae. Preliminary research using radioactive isotopes (tritium) shows that the radioactive marker does pass from the mother to the larvae (Vannini et al. 1985).

Table 4.—Mortality rates at 10% RH of larvae on the mother (OM), without the mother and aggregated (WM), without mother and isolated from each other (IS). Number of broods = 13. T = statistics of Wilcoxon matched-pairs test (two-tailed). N = number of matched pairs whose difference is not zero.

treatments:			
OM:	OM: 36/102 (35.3%)	WM: 55/104 (52.9%)	IS: 63/106 (59.4%)
	OM vs WM	OM vs IS	WM vs IS
N=	12	11	10
T=	14	7	23
P	<0.005	<0.002	n.s.

ACKNOWLEDGMENTS

We wish to thank Profs. L. Pardi and A. Ercolini for reading the manuscript. This study was supported by a grant of the Ministero della Pubblica Istruzione (fondi locali 60%).

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Manuscript received October 1984, revised July 1985.